

AMAHA SINGLE-AXIS ROBOT FLIP-X series

T4/T4H T5/T5H

User's Manual



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Introduction

The YAMAHA FLIP-X series is a family of single-axis industrial robots that use the absolute positioning method as a standard feature to improve ease of use, resistance to environmental conditions and maintenance work. A wide varaiety of product lineup allows you to select the desired robot model that best matches your application.

This user's manual describes the safety measures, handling, adjustment and maintenance of FLIP-X series robots for correct, safe and effective use. Be sure to read this manual carefully before installing the robot. Even after you have read this manual, keep it in a safe and convenient place for future reference.

- This user's manual should be used with the robot and considered an integral part of it. When the robot is moved, transferred or sold, send this manual to the new user along with the robot. Be sure to explain to the new user the need to read through this manual.
- Specifications of robot models other than standard models may be omitted in this manual
 if they are common to those of standard models. In this case, refer to the specifications of
 standard models.
- For details on specific operation of the robot, refer to the separate user's manual for the robot controller being used.

NOTES

- The contents of this manual are subject to change without prior notice.
- While every effort has been made to ensure the contents of this manual are correct, please contact us if you find any part of this manual to be unclear, confusing or inaccurate.

YAMAHA MOTOR CO., LTD. IM Operations

MEMO

Chapter 1

About Safety

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MEMO

1-1 Safety Information

Industrial robots are highly programmable, mechanical devices that provide a large degree of freedom when performing various manipulative tasks.

To ensure correct and safe use of YAMAHA industrial robots, carefully read this manual and make yourself well acquainted with the contents. FOLLOW THE WARNINGS, CAUTIONS AND INSTRUCTIONS INCLUDED IN THIS MANUAL. Failure to take necessary safety measures or mishandling due to not following the instructions in this manual may result in trouble or damage to the robot and injury to personnel (robot operator or service personnel) including fatal accidents.

Warning information in this manual is shown classified into the following items.



Failure to follow DANGER instructions will result in severe injury or death to the robot operator, bystanders or persons inspecting or repairing the robot.

A WARNING

Failure to follow WARNING instructions could result in severe injury or death to the robot operator, bystanders or persons inspecting or repairing the robot.

ACAUTION

Failure to follow CAUTION instructions may result in injury to the robot operator, bystanders or persons inspecting or repairing the robot, or damage to the robot and/or robot controller.

NOTE

Explains the key point in the operation in a simple and clear manner.

Refer to the user's manual by any of the following methods to operate or adjust the robot safely and correctly.

- 1. Operate or adjust the robot while referring to the printed version of the user's manual (available for an additional fee).
- 2. Operate or adjust the robot while viewing the CD-ROM version of the user's manual on your computer screen.
- 3. Operate or adjust the robot while referring to a printout of the necessary pages from the CD-ROM version of the user's manual.

It is not possible to list all safety items in detail within the limited space of this manual. So it is essential that the user have a full knowledge of basic safety rules and also that the operator makes correct judgments on safety procedures during operation.

For specific safety information and standards, refer to the applicable local regulations and comply with the instructions. This manual and warning labels supplied with or attached to the robot are written in English. Unless the robot operators or service personnel understand English, do not permit them to handle the robot.

* Cautions regarding the official language of EU countries
For equipment that will be installed in EU countries, the language used for the user's manuals, CE declarations, and operation screen characters is English only.
Warning labels only have pictograms or else include warning messages in English.
In the latter case, Japanese messages might be added.

1-2 Essential Caution Items

Particularly important cautions for handling or operating the robot are described below. In addition, safety information about installation, operation, inspection and maintenance is provided in each chapter. Be sure to comply with these instructions to ensure safe use of the robot.

- (1) Observe the following cautions during automatic operation.
 - · Install a safeguard (protective enclosure) to keep any person from entering within the movement range of the robot and suffering injury due to being struck by moving parts.
 - · Install a safety interlock that triggers emergency stop when the door or panel is opened.
 - · Install safeguards so that no one can enter inside except from doors or panels equipped with safety interlocks.
 - The warning labels shown in Fig. 1-1 are supplied with the robot and should be affixed to conspicuous spots on doors or panels equipped with safety interlocks.

A DANGER

Serious injury or death will result from impact with moving robot.

- · Keep outside of guard during operation.
- · Lock out power before approaching robot.



Fig. 1-1 Warning label 1

(2) Use caution to prevent hands or fingers from being pinched or crushed. Warning labels 2 (Fig. 1-2) are affixed to the robot.



Moving parts can pinch or crush. Keep hands away from robot arms.

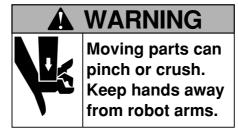


Fig. 1-2 Warning label 2

- (3) Follow the instructions on listed on warning labels and in this manual.
 - · Be sure to read the warning labels and this manual carefully and make sure you thoroughly understand their contents before attempting installation and operation of the robot.
 - · Before starting robot operation, be sure to reread the procedures and cautions relating to your work as well as descriptions in this chapter (Chapter 1, "About Safety").
 - Never install, adjust, inspect or service the robot in any manner that does not comply with the instructions in this manual.
 - The warning labels shown in Fig. 1-3 are supplied with the robot and should be affixed to the robot or conspicuous spots near the robot.



Improper installation or operation can result in serious injury or death. Read the user's manual and all warning labels before operation.

A WARNING

Improper Installation or operation can result in serious injury or death. Read user's(owner's) manual and all warning labels before operation.

Fig. 1-3 Warning label 3

(4) Do not remove, alter or stain the warning labels.

A WARNING

If warning labels are removed or difficult to see, then essential precautions might not be taken, resulting in accidents.

- · Do not remove, alter or stain the warning labels on the robot.
- Do not allow the warning labels to be hidden by devices installed onto the robot by the user.
- · Provide proper lighting so that the symbols and instructions on the warning labels can be clearly seen even from outside the safeguard enclosure.
- (5) Do not use the robot in environments containing inflammable gas, etc.



- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire might otherwise result.
- (6) Do not use the robot in locations possibly subject to electromagnetic interference, etc.



Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunctions might otherwise occur.

(7) Use caution when releasing the brake of a vertical use robot.

A WARNING

The vertical axis will slide down when the brake is released, causing a hazardous situation.

- · Press the emergency stop button and prop up the vertical axis with a support stand before releasing the brake.
- · Be careful not to let your body get caught between the vertical axis and installation base when releasing the brake to perform direct teach.
- (8) Provide safety measures for end effector (gripper, etc.).

A WARNING

- End effectors must be designed and manufactured so that they create no hazards (for example, a workpiece that comes loose) even if power (electricity, air pressure, etc.) is shut off or power fluctuations occur.
- · If there is a possible danger that the object gripped by the end effector may fly off or drop, then provide appropriate safety protection taking into account the object size, weight, temperature and chemical properties.
- (9) Use caution when removing the motor. (Vertical use robots)



The vertical axis will slide down when the motor is released, causing a hazardous situation.

- · Turn off the robot controller and prop up the vertical axis with a support stand before removing the motor.
- Be careful not to let your body get caught between the vertical axis parts and installation base.
- (10) Be careful not to touch the motor or speed reduction gear casing when hot.



The motor and speed reduction gear casing are extremely hot after automatic operation, so burns may occur if these are touched.

Before handling these parts during inspection or servicing, turn off the controller, wait for a while and check that the part has cooled.

(11) Take the following safety precautions during inspection of controller.

A WARNING

- · When you need to touch the terminals or connectors on the outside of the controller during inspection, always first turn off the controller power switch and also the power source in order to prevent possible electrical shock.
- · Never touch any internal parts of the controller.
- · Refer to the "YAMAHA Robot Controller User's Manual" for precautions on handling the controller.

(12) Use caution not to touch the controller cooling fan.



- · Bodily injury may occur from coming into contact with the cooling fan while it is rotating.
- · When removing the fan cover for inspection, first turn off the controller and make sure the fan has stopped.
- (13) Consult us for corrective action when the robot is damaged or malfunctions occur.



If any part of the robot is damaged or any malfunction occurs, continuing the operation may be very dangerous. Please consult your YAMAHA sales office or dealer for corrective action.

Damage or Trouble	Possible Danger
Damage to machine harness or robot cable	Electrical shock, malfunction of robot
Damage to exterior of robot	Flying outwards of damaged parts during robot operation
Abnormal operation of robot (positioning error, excessive vibration, etc.)	Malfunction of robot
Z-axis brake trouble	Dropping of load

(14) Protective bonding



Be sure to ground the robot and controller to prevent electrical shock.

(15) Be sure to make correct parameter settings.



The robot must be operated with correct acceleration coefficients according to the tolerable moment of inertia and manipulator tip mass or moment of inertia. If these are not correct, drive unit service life may end prematurely, and damage to robot parts or residual vibration during positioning may result.

(16) Follow the specified procedures when installing, adjusting or inspecting the robot.

A WARNING

Always follow the specified procedures when installing, adjusting or inspecting the robot. Never attempt any procedure not described in this manual.

(17) Do not attempt any repair, parts replacement and modification.

A WARNING

Do not attempt any repair, parts replacement and modification unless described in this manual.

These works require technical knowledge and skill, and may also involve work hazards.

- (18) Location for installing the controller and the programming box or Handy Terminal The robot controller, programming box, and Handy Terminal should be installed at a location that is outside the robot movement range yet where it is easy to operate and view the robot performing tasks.
- (19) Protect electrical wiring and hydraulic/pneumatic hoses as needed.

 Install a cover or similar item to protect the electrical wring and hydraulic/pneumatic hoses from possible damage.

(20) Install an operation status light.

Install an operation status light (signal light tower, etc.) at an easy-to-see position so the operator will know whether the robot is merely stopped or is in emergency-error stop.

(21) Clean work tools, etc.

Work tools such as welding guns and paint nozzles which are mounted in the robot arm will preferably be cleaned automatically.

(22) Provide adequate lighting.

Make sure to provide enough lighting to ensure safety during work.

(23) Prevent the gripped object from flying outwards.

If the object or workpiece gripped by the robot might fly outward or drop and create a hazard to the operator, then protective equipment should be installed by taking the size, weight, temperature and chemical properties of the object into account.

(24) Draw up "work instructions" and makes sure the operator learns them well.

Decide on "work instructions" for the following items in cases where personnel must work within the robot movement range to perform teaching, maintenance or inspection. Make sure the workers know these "work instructions" well.

- (1) Robot operating procedures needed for tasks such as startup procedures and handling switches
- (2) Robot speeds used during tasks such as teaching
- (3) Methods for workers to signal each other when two or more workers perform tasks
- (4) Steps that the worker should take when a problem or emergency occurs
- (5) Steps to take after the robot has come to a stop when the emergency stop device was triggered, including checks for cancelling the problem or error state and safety checks in order to restart the robot.
- (6) In cases other than above, the following actions should be taken as needed to prevent hazardous situations due to sudden or unexpected robot operation or faulty robot operation, as listed below.
 - 1. Show a display on the operator panel
 - 2. Ensure the safety of workers performing tasks within the robot movement range
 - 3. Clearly specify position and posture during work
 Position and posture where worker can constantly check robot movements and immediately move to avoid trouble if an error/problem occurs
 - 4. Install noise prevention measures
 - 5. Use methods for signaling operators of related equipment
 - 6. Use methods to decide that an error has occurred and identify the type of error

Implement the "work instructions" according to the type of robot, installation location, and type of work task.

When drawing up the "work instructions", make an effort to include opinions from the workers involved, equipment manufacture's technicians, and workplace safety consultants, etc.

(25) Display a sign on operation panel during work

Display an easy to understand sign or message on the programming box, Handy Terminal, and operation panel during the job task, to prevent anyone other than the operators for that job task from mistakenly operating a start or selector switch. If needed, take other measures such as locking the cover on the operation panel.

(26) Make daily and periodic inspections.

- (1) Always make sure that daily and periodic inspections are performed, and make a prework check to ensure there are no problems with the robot or related equipment. If a problem or abnormality is found, then promptly repair it or take other measures as necessary.
- (2) When you make periodic inspections or repairs, make a record and store it for at least 3 years.

1-3 Industrial Robot Operating and Maintenance Personnel

Operators or persons who handle the robot such as for teaching, programming, movement check, inspection, adjustment, and repair must receive appropriate training and also have the skills needed to perform the job correctly and safely. They must read the user's manual carefully to understand its contents before attempting the robot operation.

Tasks related to industrial robots (teaching, programming, movement check, inspection, adjustment, repair, etc.) must be performed by qualified persons who meet requirements established by local regulations and safety standards for industrial robots.

1-4 Robot Safety Functions

(1) Overload detection

This function detects an overload applied to the motor and shuts off the servo power.

(2) Overheat detection

This detects an abnormal temperature rise in the controller driver and shuts off the servo power.

If an overload or overheat error occurs, take the following measures.

- 1. Insert a timer in the program.
- 2. Reduce the acceleration coefficient.

(3) Soft limits

Soft limits can be set on each axis to limit the working envelope in manual operation after return-to-origin and during automatic operation.

Note: The working envelope is the area limited by soft limits.



Soft limits must be set within the movement range (mechanical stopper). If the soft limit is set outside the movement range, the robot axis may collide with the mechanical stopper at high speed, causing the object gripped by the end effector to fly or drop and the robot to malfunction.

(4) Mechanical stoppers

If the servo power is suddenly shut off during high-speed operation by emergency stop or safety functions, these mechanical stoppers prevent the axis from exceeding the movement range.

No mechanical stopper is provided on the rotating axis.

Note: The movement range is the area limited by mechanical stoppers.



Axis movement will not stop immediately after the servo power supply is shut off by emergency stop or other safety functions.

(5) Vertical axis brake

An electromagnetic brake is installed on the vertical use robot to prevent the vertical axis from sliding down when servo power is turned off. This brake is working when the controller is off or the vertical axis servo power is off even when the controller is on.

The vertical axis brake can be released by means of the programming box or by a command in the program when the controller is on.



The vertical axis will slide down when the brake is released, creating a hazardous situation.

- · Press the emergency stop button and prop the vertical axis with a support stand before releasing the brake.
- Use caution not to let your body get caught between the vertical axis and installation base when releasing the brake to perform direct teach.

1-5 Safety Measures for the System

Since the robot is commonly used in conjunction with an automated system, dangerous situations are more likely to occur from the automated system than from the robot itself. Accordingly, appropriate safety measures must be taken on the part of the system manufacturer according to the individual system. The system manufacturer should provide a proper instruction manual for safe, correct operation and servicing of the system.

1-6 Trial Operation

After making installations, adjustments, inspections, or maintenance or repairs to the robot, make a trial run using the following procedures.

- (1) If a safeguard enclosure has not yet been provided right after installation of the robot, rope off or chain off around the movement area of the manipulator in place of the safeguard, and observe the following points.
 - 1. Use sturdy, stable posts which will not fall over easily.
 - 2. The rope or chain should be easily visible by everyone around the robot.
 - 3. Place a sign to keep the operator or other personnel from entering the movement range of the manipulator.
- (2) Check the following points before turning on the controller.
 - 1. Is the robot securely and correctly installed?
 - 2. Are the electrical connections to the robot correct?
 - 3. Are items such as air pressure correctly supplied?
 - 4. Is the robot correctly connected to peripheral equipment?
 - 5. Have safety measures (safeguard enclosure, etc.) been taken?
 - 6. Does the installation environment meet the specified standards.
- (3) After the controller is turned on, check the following points from outside the safeguard enclosure.
 - 1. Does the robot start and stop as intended? Can the operation mode be selected correctly?
 - 2. Does each axis move as intended within the soft limits?
 - 3. Does the end effector move as intended?
 - 4. Are the signal transmissions to the end effector and peripheral equipment correct?
 - 5. Does emergency stop work?
 - 6. Are the teaching and playback functions normal?
 - 7. Are the safeguard enclosure and interlock working as intended?
 - 8. Does the robot move correctly during automatic operation?

1-7 Work Within the Safeguard Enclosure

(1) Work within the safeguard enclosure

When work is required inside the safeguard enclosure, always turn off the controller and place a sign indicating that the robot is being adjusted or serviced in order to keep any other person from touching the controller switch or operation panel, except for the following cases.

- 1) Soft limit settings (See Section 4 in Chapter 4.)
- 2) Teaching

For item 1), follow the precautions and procedure for each section. To perform item 2), refer to the description in (2) below.

(2) Teaching

When performing teaching within the safeguard enclosure, comply with the instructions listed below.

1)Check or perform the following points from outside the safeguard enclosure.

- 1. Make sure that no hazards are present within the safeguard enclosure by a visual check.
- 2. Check that the programming box/Handy Terminal operate correctly.
- 3. Check that no failures are found in the robot.
- 4. Check that emergency stop works correctly.
- 5. Select teaching mode and prohibit automatic operation.
- 2) Never enter the movement range of the manipulator while within the safeguard enclosure.

1-8 Automatic Operation

Automatic operation described here includes all operations in AUTO mode.

- (1) Check the following before starting automatic operation.
 - 1. No one is within the safeguard enclosure.
 - 2. The programming box/Handy Terminal and tools are in their specified locations.
 - 3. The alarm or error lamps on the robot and peripheral equipment do not flash.
 - 4. The safeguard enclosure is securely installed with safety interlocks actuated.
- (2) Observe the following during automatic operation or in cases where an error occurs.
 - 1)After automatic operation has started, check the operation status and warning lamp to ensure that the robot is in automatic operation.
 - 2) Never enter the safeguard enclosure during automatic operation.
 - 3)If an error occurs in the robot or peripheral equipment, observe the following procedure before entering the safeguard enclosure.
 - 1. Press the emergency stop button to set the robot to emergency stop.
 - 2. Place a sign on the start switch, indicating that the robot is being inspected in order to keep any other person from touching the start switch and restarting the robot.

1-9 Warranty

The YAMAHA robot and/or related product you have purchased are warranted against the defects or malfunctions as described below.

Warranty description : If a failure or breakdown occurs due to defects in materials

or workmanship in the genuine parts constituting this YAMAHA robot and/or related product within the warranty period, then YAMAHA will repair or replace those parts free

of charge (hereafter called "warranty repair").

Warranty Period : The warranty period ends when any of the following ap-

plies:

(1) After 18 months (one and a half year) have elapsed from the date of shipment

(2) After one year has elapsed from the date of installation

(3) After 2,400 hours of operation

Exceptions to the Warranty: This warranty will not apply in the following cases:

(1) Fatigue arising due to the passage of time, natural wear and tear occurring during operation (natural fading of painted or plated surfaces, deterioration of parts subject to wear, etc.)

(2) Minor natural phenomena that do not affect the capabilities of the robot and/or related product (noise from computers, motors, etc.).

(3) Programs, point data and other internal data that were changed or created by the user.

Failures resulting from the following causes are not covered by warranty repair.

- Damage due to earthquakes, storms, floods, thunderbolt, fire or any other natural or manmade disasters.
- 2) Troubles caused by procedures prohibited in this manual.
- 3) Modifications to the robot and/or related product not approved by YAMAHA or YAMAHA sales representatives.
- 4) Use of any other than genuine parts and specified grease and lubricants.
- 5) Incorrect or inadequate maintenance and inspection.
- 6) Repairs by other than authorized dealers.

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Installation and Connections

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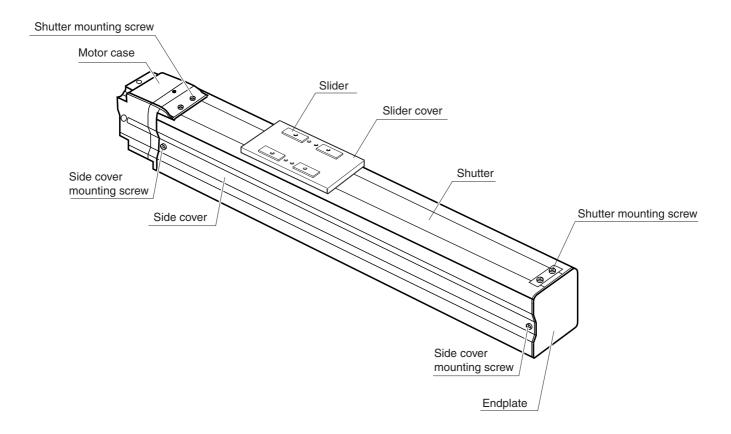
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2-1 Checking the product

After unpacking, make sure that all components and accessories are included (as specified in your order). Also check the product for any damage on the exterior which might have occurred during transportation.

If there are any missing parts or damage due to transportation, please notify your YAMAHA sales office or dealer immediately.

2-2 Robot part names



2-3 Robot Installation Conditions

Be sure to install the robot in the following environments.

Items	Specifications
Allowable ambient temperature	0 to 45°C
Allowable ambient humidity	35 to 85% RH (non condensation)
Altitude	0 to 1000 meters above sea level
Ambient environments	Avoid installing near water, cutting water, oil, dust, metallic chips and organic solvent.
	Avoid installation near corrosive gas and corrosive materials.
	Avoid installation in atmosphere containing inflammable gas, dust and liquid.
	Avoid installation near objects causing electromagnetic interference, electrostatic discharge and radio frequency interference.
Vibration	Do not subject to impacts or vibrations.
Working space	Allow sufficient space margin to perform jobs (teaching, inspection, repair, etc.)

For detailed information on how to install the robot controller, refer to the separate "YAMAHA Robot Controller User's Manual".



Avoid installing the robot in locations where the ambient conditions may exceed the allowable temperature or humidity, or in environments where excessive moisture, corrosive gases, metallic powder or dust are generated. Malfunctions, failures or short circuits may otherwise result.

A WARNING

- This robot was not designed for operation in environments where inflammable or explosive substances are present.
- Do not use the robot in environments containing inflammable gas, dust or liquids. Explosions or fire could otherwise result.

A WARNING

Avoid using the robot in locations subject to electromagnetic interference, electrostatic discharge or radio frequency interference. Malfunctions may otherwise occur.

A WARNING

Do not use the robot in locations subject to excessive vibration. Robot installation bolts may otherwise become loose causing the manipulator to fall over.

2-4 Installation base

To mount the robot, use an installation base that satisfies the following conditions.

The installation base is subjected to a great deal of stress while the robot is in operation.
 Prepare a sufficiently rigid and stable installation base, taking into account the robot weight including the end effector (gripper) and workpiece.



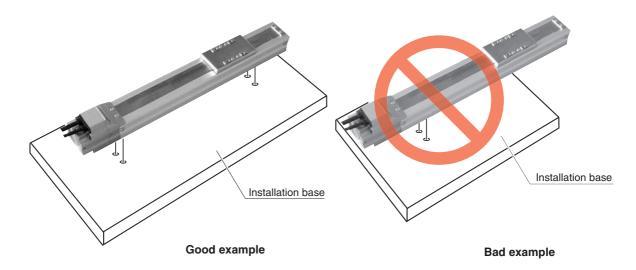
If the installation base is not sufficiently rigid and stable, vibration (resonance) may occur during operation, causing adverse effects on the robot work.

2) The installation base surface must be machined within a flatness of ± 0.05 mm/500mm.



The robot positioning accuracy might decrease if the installation surface precision is insufficient.

3) Use an installation base of sufficient size to match the robot body so that the robot can be installed with the specified number of bolts. Avoid installing the robot with less than the specified number of bolts (4 bolts) or installing the robot closer to one end as shown at the lower right.





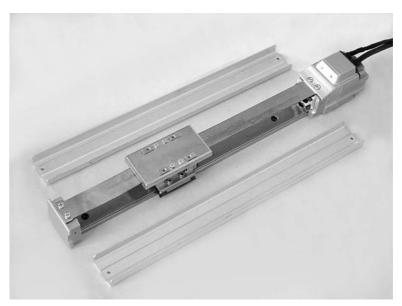
Using less than the specified number of bolts to install the robot may cause vibration and poor positioning accuracy.

2-5 Installing the robot

- Tap holes into the installation base where the robot is to be secured.
 For hole diameter and pitch, see the external view and dimensions in "4-1 Robot specifications" of Chapter 4.)
- 2) Remove the screws securing the side covers of the robot and remove the side covers (on both sides).





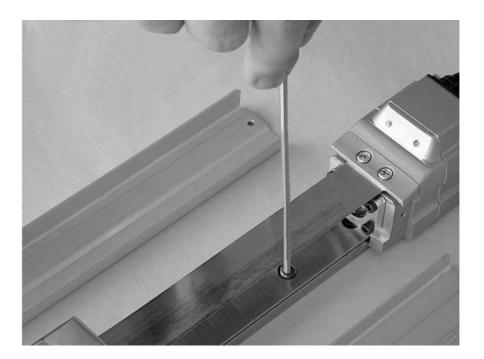


NOTE

If necessary, move the slider to a location where it does not block the installation holes on the bottom of the robot frame.

3) Secure the robot to the base with the specified bolts (4 bolts) and torque. The bolts and tightening torque are shown below.

Robot Type	Bolt	Tightening torque	
T4/T4H	Hex socket-head M4 bolt(length: longer than 12mm is recommended)	20kg cm to 45kg cm	
T5/T5H	Hex socket-head M4 bolt(length: longer than 15mm is recommended)	- 30kg_cm to 45kg_cm	





Be careful not to damage the shutter when tightening the bolts.

A WARNING

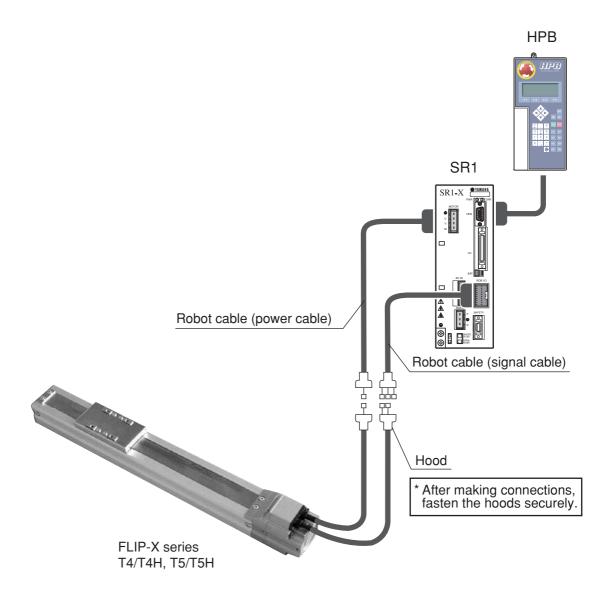
Be sure to tighten the bolt to the correct torque. The wrong torque may not only cause robot position errors but also lead to serious accidents.

4) Reattach the side covers after installing the robot.

2-6 Connections

2-6-1 Connecting the robot cables

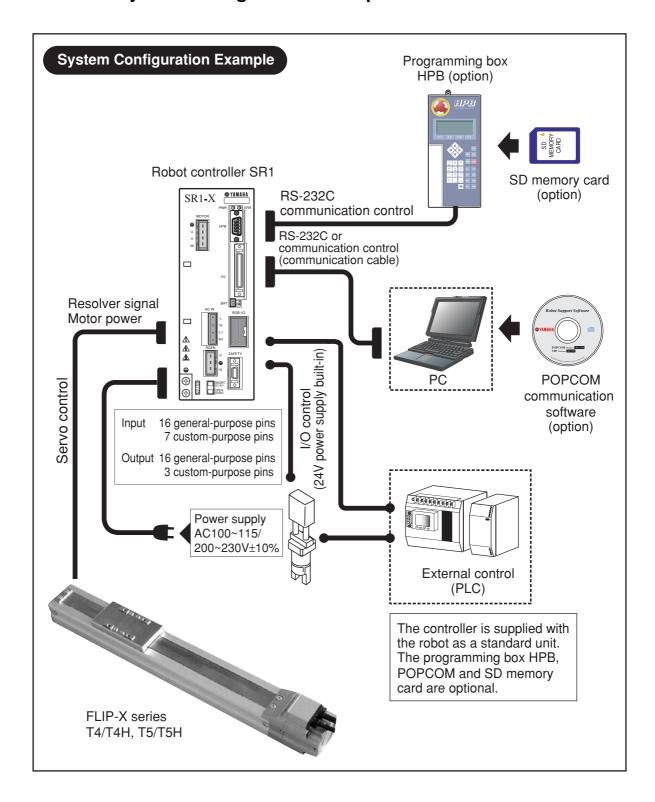
Connect the robot cables to the mating connectors on the controller as shown. Refer to the SR1 robot controller user's manual for the controller connectors.



A WARNING

Before connecting the cables, check that there are no bends or breaks in the robot cable connector pins and that the cables are not damaged. Bent or broken pins or cable damage may cause robot malfunctions.

2-6-2 System Configuration Example



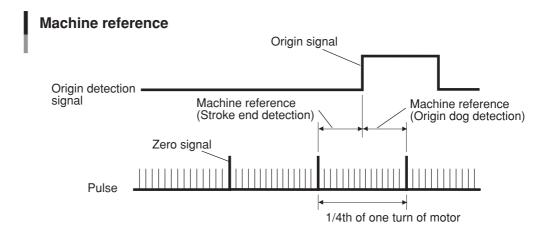
2-7 About machine reference

The position detector built into the motor issues a "0" pulse each time the motor rotates 1/4th of one turn. When return-to-origin is performed, a difference in distance occurs between the position where the origin signal is detected and the point at which the next "0" pulse is received. This is called the machine reference and is usually expressed as a percent, with 100% being equal to 1/4th of one turn of the motor. The machine reference value must be within the allowable range (25 to 75%) to maintain axis movement repeatability.

To check the machine reference value, an optional programming box HPB is needed. The machine reference value is displayed on the LCD screen of the programming box when return-to-origin is complete. (See the figure below.)

NOTE

The FLIP-X series uses an absolute type position detector. You do not have to perform return-to-origin each time the robot controller is turned on and readjust the machine reference value. If for some reason the machine reference adjustment becomes necessary, please contact YAMAHA sales office or dealer.



Machine reference value display examples



SR1, ERCX, ERCD

2-8 Duty

To achieve maximum service life for the YAMAHA single-axis robots, the robot must be operated within the allowable duty (50%).

The duty is calculated as follows:

Duty (%) =
$$\frac{\text{Operation time}}{\text{Operation time} + \text{Non-operation time}} \quad 100$$

If the robot duty is high, an error such as "overload" or "overheat" occurs. In this case, increase the stop time to reduce the duty.

Periodic Inspection

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MEMO

3-1 Before beginning work

Periodic inspection and maintenance are essential to ensure safe and efficient operation of YAMAHA robots. This chapter describes periodic inspection items and procedures for the FLIP-X series. Before beginning work, read the precautions below and also in Chapter 1 "About Safety" and follow the instructions.

A DANGER

If the inspection or maintenance procedure calls for operation of the robot, stay out of the working area of the robot during operation. Do not touch any parts inside the controller.

Keep watching the robot movement and surrounding area so that the operator can press the emergency stop button if any danger occurs.

A WARNING

- · When the robot does not need to be operated during adjustment or maintenance, always turn off the controller and the external switch board.
- Do not touch internal parts of the controller for 10 minutes after the controller has been turned off.
- · Use only lubricant and greases specified by YAMAHA sales office or dealer.
- Use only parts specified by YAMAHA sales office or dealer. Take sufficient care not to allow any foreign matter to contaminate them during adjustment, parts replacement or reassembly.
- Do not modify any parts on the robot or controller. Modification may result in unsatisfactory specifications or threaten operator safety.
- · When adjustment or maintenance is complete, retighten the bolts and screws securely.
- During robot adjustment or maintenance, place a sign indicating that the robot is being adjusted or serviced, to prevent others from touching the control keys or switches. Provide a lock on the switch keys or ask someone to keep watch as needed.

When applying grease to the ball screws and linear guide, take the following precautions.



Precautions when handling grease:

- Inflammation may occur if this gets in the eyes.
 Before handling the grease, wear your safety goggles to ensure the grease will not come in contact with the eyes.
- · Inflammation may occur if the grease comes into contact with skin. Be sure to wear protective gloves to prevent contact with skin.
- · Do not take orally or eat. (Eating will cause diarrhea and vomiting.)
- · Hands and fingers might be cut when opening the container, so use protective gloves.
- · Keep out of the reach of children.
- Do not heat the grease or place near an open flame since this could lead to sparks and fires.

Emergency Treatment:

- · If grease gets in the eyes, wash liberally with pure water for about 15 minutes and consult a physician for treatment.
- · If grease comes in contact with the skin, wash away completely with soap and water.
- · If taken internally, do not induce vomiting but promptly consult a physician for proper treatment.

3-2 Periodic inspection

3-2-1 Daily inspection

Check the following points on a daily basis, before and after robot operation.

Checkpoints	Check items	Notes
Cables and shutter	Check for scratches, dents, and excessively tight bends.	Replace if
Ball screws and bearings	Check for unusual vibration and noise.	necessary.
Motor	Check for unusual vibration and noise, and for abnormal temperature rise.	See "3-4" in this chapter.

3-2-2 Three-month inspection

Check the following points every 3 months and apply grease if needed.

Checkpoints	Check items	Notes
Ball screw, linear guide and ball bushing	Check for dirt or grime. If dirt or grime is found, clean the part. Apply grease after cleaning. Apply grease if the items checked are dry or do not have enough grease. Recommended grease is as follows: Standard model: Use Alvania No. (Showa Shell), Daphne Eponex No.2 (Idemitsu) Clean room model: Use LG-2 (NSK)	See "3-3" in this chapter.
Shutter	Check for slack. Adjust if necessary.	See "3-5" in this chapter.



Using a grease other than recommended by YAMAHA may shorten the service life of the ball screw, linear guide and linear bushing shaft.

3-2-3 Six-month inspection

Check the following points every six months, and make adjustments or apply grease if necessary.

Checkpoints	Check items	Notes
Main bolts and screws on robot	Check for looseness. If loose, tighten.	
Ball screw and linear guide	Check for looseness in the ball screw and linear guide. Tighten if necessary. Check for vibration during operation. Tighten drive section, and X and Y axis installation bolts if necessary. Check for wear and backlash. If any abnormality is found, contact YAMAHA sales office or dealer.	If problem is not solved or wear and backlash are found, please contact us.
Controller	Check for loose terminals. Check for loose connectors.	
Lubrication of ball screw nut and linear guides	Apply Alvania No.2 (Showa Shell), Daphne Eponex No.2 (Idemitsu Sekiyu) to the ball screw nut and linear guides.	See "3-3" in this chapter



Using a grease other than recommended by YAMAHA may shorten the service life of the ball screw, linear guide and linear bushing shaft.

3-2-4 Three-year inspection

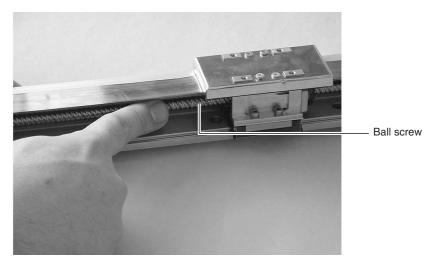
Inspect the following points once every three years, and contact us if any problem is found. Set an earlier inspection interval if parts are subject to long-term or frequent usage.

Checkpoints	Check items	Notes
Ball screw nut sections and linear guides	Check for wear and looseness in the ball screw, nut and linear guide.	Contact us if trouble is found.

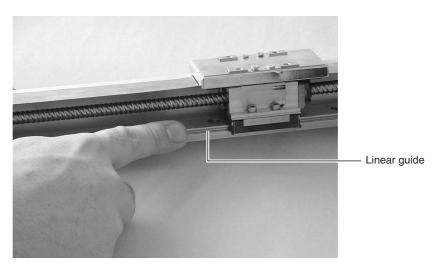
3-3 Applying grease

Follow these instructions when applying grease to the T4/T5 robot ball screws and linear guides during periodic maintenance. Make sure that the controller power switch is off before beginning work.

- 1) Remove the screw securing the robot side covers and remove the side covers.
- 2) Coat the ball screw and linear guides with grease by hand and move the slider back and forth to spread the grease.



Applying grease to the ball screw



Applying grease to the linear guide

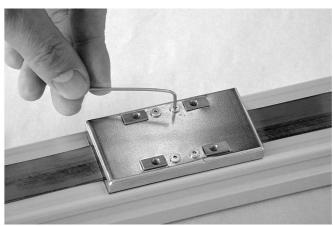
3) Reattach the side covers.

3-4 Replacing the shutter

Use the following procedure when the shutter must be replaced. Make sure that the controller power switch is off before beginning work.

(If the motor has a trouble and must be replaced, please contact YAMAHA sales office or dealer.)

1) Remove the 4 screws securing the slider cover and take off the slider cover.

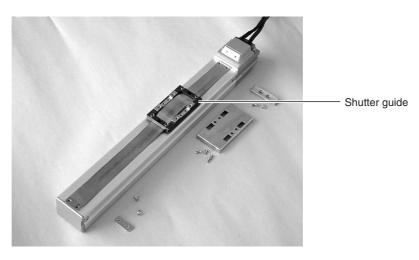


2) Remove the screws securing the shutter. Remove the 2 screws on the endplate side and the 2 screws on the motor side.





3) Remove the shutter and shutter guide from the robot.



4) Remove the shutter from the shutter guide and pass the new shutter through it.

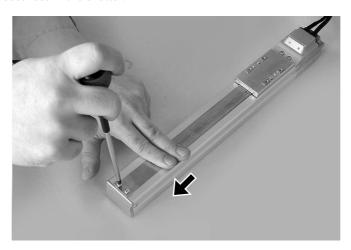


5) Reinstall the shutter and the slider cover using the reverse of the above procedure.

NOTE

Do not fully tighten the screws to secure the shutter on the endplate side at this time. Fully tighten these screws after adjusting for shutter looseness in step 6.

6) Tighten the screws while pulling on the shutter with your fingers so that there is no looseness in the shutter.





Do not press down on the shutter with excessive force. Pressing down hard on the shutter may cause the shutter to warp.

3-5 Adjusting shutter looseness

The shutter may elongate with continued use. In such cases, adjust as follows.

- 1) Slightly loosen the two screws securing the endplate side of the shutter. (Do not remove.)
- 2) While pulling on the shutter with your fingers, tighten the screws so that there is no looseness. See step 6 of "3-4 Replacing the shutter".

Specifications

4-1	Robots	specifications	4-3
		T4/T4H	
		T5/T5H	
4-2		vo motor specifications	
	4-2-1	AC servo motor termination	4-7
	4-2-2	Brake cable specifications (vertical use)	4-8
4-3	Robot (cable	4-9

4-1 **Robot specifications**

4-1-1 **T4/T4H**

■ Basic specifications

Motor output AC (W)			30			
Repeated po	±0.02					
Deceleration	mecha	nism	Ball so	rew (Clas	s C10)	
Ball screw le	ad (mn	1)	12	6	2	
Maximum sp	eed (m	m/sec)	720	360	120	
Maximum payload Horizontal installation		4.5	6	6		
(kg)		Vertical installation	1.2	2.4	7.2	
Rated thrust	Rated thrust (N)			64	153	
Stroke (mm)	Stroke (mm)			50 to 300 (50 pitch)		
Cable length	(m)		Standa	rd: 3.5 Ol	P: 5, 10	
	T4	Horizontal installation		EDOV EDOD		
0 1 11	14	Vertical installation	ERCX, ERCD		,U	
Controller	TALL	Horizontal installation		CD1 V 05		
T4H		Vertical installation	SR1-X-05		1	

С

75

135

62

142

66

33

58

26

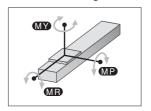
58

223 515

340

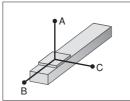
1585

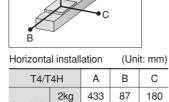
■ Static loading moment



	(Unit: N·m)
MY	15
MP	19
MR	18

■ Allowable overhang*





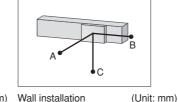
4.5kg

3kg

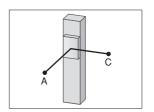
Lead 12

Lead 6

Lead 2



vali iristaliation			(011	ıı. 111111 <i>)</i>	
T4/T4H		Α	В	С	
1 140	2kg	149	54	376	
Lead 12	4.5kg	50	1	148	
	3kg	107	24	380	
Lead 6	6kg	31	0	195	
1 1 0	3kg	113	24	1180	
Lead 2	6kg	32	0	440	

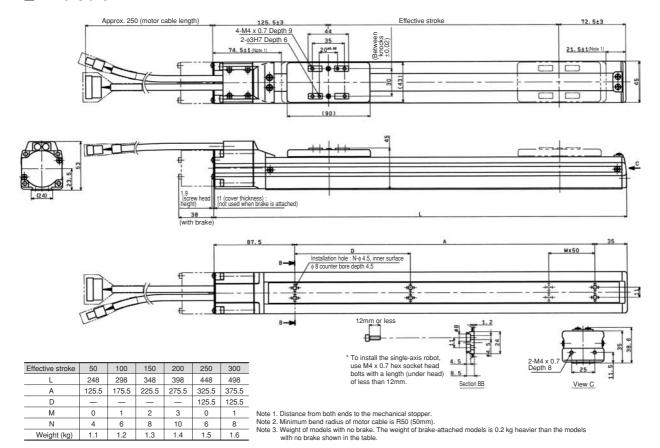


Vertical installation (Unit: mm) T4/T4H Α С 1.2kg 125 125 Lead 12 2.4kg Lead 6 56 57 42 3kg 41 Lead 2 0 0

^{*1} Positioning repeatability in one direction.

^{*} Distance from center of the top face of the slider (carriage) to the gravity center of the item being carried. (This is calculated assuming that the service life of the guide is 10,000km.)

■ Dimensions

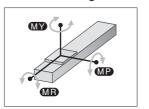


4-1-2 T5/T5H

■ Basic specifications

Motor output AC (W) 30					
Repeated positioning accuracy (mm) *1			±0.02		
Deceleration	mecha	anism	Ball sc	rew (Clas	s C10)
Ball screw le	ad (mn	า)	20	12	6
Maximum sp	eed (m	ım/sec) *3	1200	800	400
Maximum payload Horizontal installation		3	5	9	
(kg)		Vertical installation	_	1.2	2.4
Rated thrust	Rated thrust (N)			32	64
Stroke (mm)			50 to 800 (50 pitch) *2		
Cable length	(m)		Standa	rd: 3.5 O	P: 5, 10
	Horizontal installation		EDOV EDOD		ND
Cantuallan	T5	Vertical installation	ERCX, ERCD		טע
Controller	TELL	Horizontal installation		CD1 V 0E	
T5H		Vertical installation	SR1-X-05		

■ Static loading moment

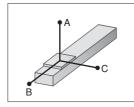


	(Unit: N·m)
MY	30
MP	34
MR	40

^{2.3} When the stroke is longer than 650mm, resonance of the ball screw may occur depending on the operation conditions (hazardous speed). In this case, reduce the speed setting on the program by referring to the maximum speeds shown in the table below.

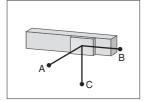
Stroke (mm)	650	700	750	800
Maximum speed (mm/sec)	960	840	720	660
SPEED setting	80%	70%	60%	55%

■ Allowable overhang*

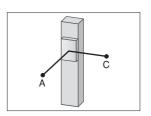




T5/T5H		Α	В	С
1 1 00	1kg	600	323	683
Lead 20	3kg	675	103	247
Lead 12	2kg	1170	159	406
	5kg	555	59	155
	3kg	1498	104	294
Lead 6	9kg	628	31	89



wan msta	(Un	it: mm)		
T5/T5H		Α	В	С
J and 00	1kg	600	291	600
Lead 20	3kg	215	73	589
1 140	2kg	368	127	1082
Lead 12	5kg	127	30	449
	3kg	263	73	970
Lead 6	9ka	54	0	400



 Vertical installation (Unit: mm)

 T5/T5H
 A
 C

 Lead 12
 1.2kg
 242
 240

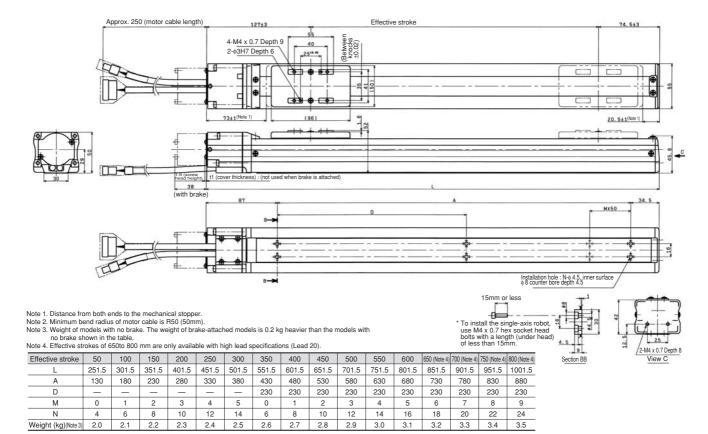
 Lead 6
 2.4kg
 113
 113

^{*1} Positioning repeatability in one direction.

^{*2 650}mm or longer strokes are only available with high lead specifications (Lead 20).

^{*} Distance from center of the top face of the slider (carriage) to the gravity center of the item being carried. (This is calculated assuming that the service life of the guide is 10,000km.)

Dimensions



4-2 AC servo motor specifications

4-2-1 AC servo motor termination

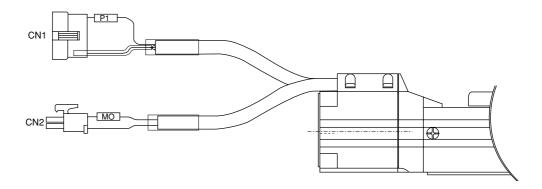
Connector specifications

No.	Parts	Type No.	Maker	Qty	Note
1	Servo motor			1	
2	Receptacle housing	SMR-09V-B	JST	1	CN1
3	Pin contact	BYM-001T-P0.6	JST	9	CN1
4	Receptacle housing	5557-04R	MOLEX	1	CN2 (4 polarities)
5	Receptacle	5556T	MOLEX	4	CN2

Connector wiring

Connector	Pin No.	Signal	Wire Color	Note
	1	S2	Blue/black	
	2	S4	Blue	
	3	S1	Yellow/black	
	4	S3	Yellow	
CN1	5	R1	White	
	6	R2	White/black	
	7	JP1	Red	
	8	JP2	Red	
	9	Shield	Black*	
	1	U	Black	
CN2	2	V	White	
CINZ	3	W	Red	
	4	PE	green/yellow	

* Heat shrinkable tube



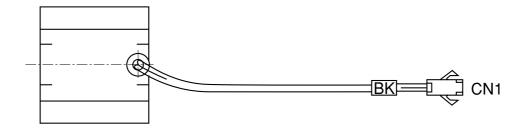
4-2-2 Brake cable specifications (vertical use)

Connector specifications

No.	Parts	Type No.	Maker	Qty	Note
1	Brake parts			1	
2	Receptacle housing	SMR-02V-B	JST	1	CN1
3	Pin contact	BYM-001T-P0.6	JST	9	CN1

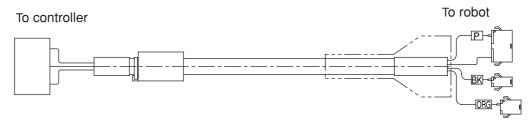
Connector wiring

Connector	Pin No.	Signal	Wire Color
CN1	1	S1	Yellow (black)
	2	S2	Yellow (black)



4-3 Robot cable

Signal cable



Parts	Signal	PIN	Connection	PIN	Parts	Wire	
			/				
Controller CN1	S2	1		1	Resolver	0.3sq Blue	SPMCU-14K
	S4	2		2		Orange	
	S1	3	<u> </u>	3		Green	
	S3	4	\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	4		Brown	
	R1	5		5		Grey	
	R2	6		6		Red	
	D.G	9		7		Clear	Shield
	BK+	17		1	Brake	Black	
	BK-	18		2		Yellow	
	ORG	12		2	ORG	Pink	
	24V	13		1		White	
	GND24	15		3		Blue/Red	

• Power cable

To controller To robot

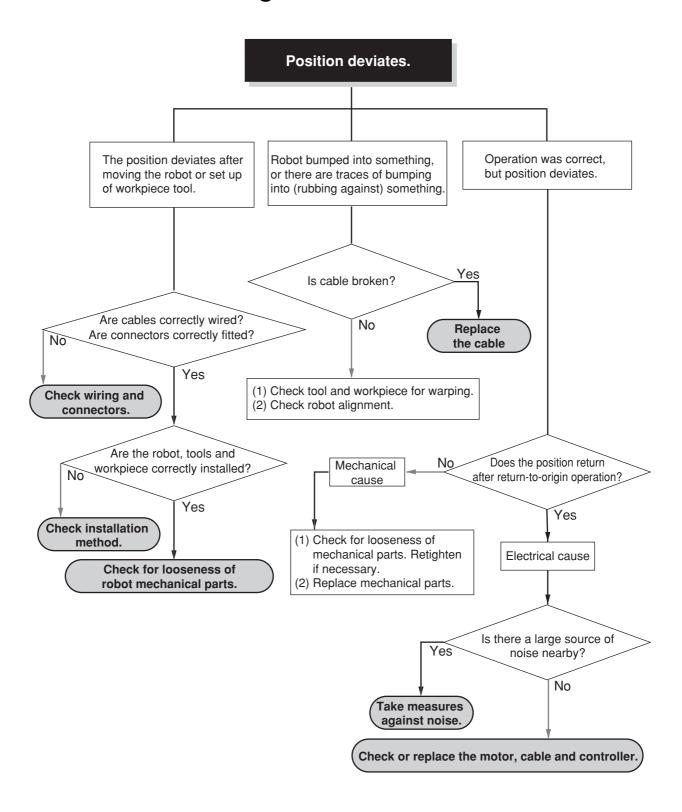
Parts	Signal	PIN	Connection	PIN	Parts	Wire	
Motor wire	FG	1		4		0.75sq	Yellow/ Green
	U	2		1		0.75sq	Red
	V	4		2		0.75sq	White
	W	3		3		0.75sq	Black

Chapter 5

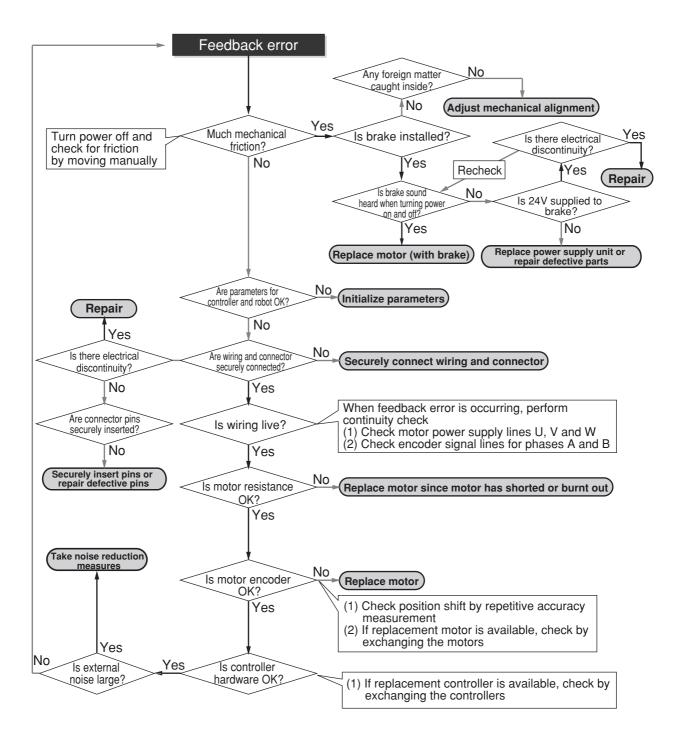
Troubleshooting

5-1	Positioning error	5-3
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5-1 Positioning error



5-2 Feedback error



User's Manual

YAMAHA Single-axis Robots

Dec. 2009

Ver. 2.01

T4/T4H T5/T5H

This manual is based on Ver. 2.01 of Japanese manual.

 $\ensuremath{\textcircled{\sc o}}$ YAMAHA MOTOR CO., LTD. IM Operations

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